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Nr. 2. Johs. Schmidt: THE PELAGIC POST-LARVAL STAGES OF THE ATLANTIC SPECIES OF *GADUS*. A MONOGRAPH. PART II. WITH ONE PLATE

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
1906

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THE PELAGIC POST-LARVAL STAGES OF THE ATLANTIC SPECIES OF *GADUS*

A MONOGRAPH

BY

JOHS. SCHMIDT

PART II

WITH ONE PLATE

KØBENHAVN
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I. INTRODUCTION

SINCE the publication of the first portion of this work I have collected a large material of pelagic *Gadus*-young by means of the "Thor" during the season 1905. On account of the investigations on the distribution of the larvae of the eel (*Leptocephalus brevirostris*) the 1905 cruise was extended from Iceland much further southwards in the Atlantic Ocean than in previous years (right to Brittany), and I thus had the opportunity of collecting myself the pelagic young of the more southerly *Gadus*-species (*G. luscus*, *minutus* and *pollachius*), which do not occur at Iceland. The success was thereby gained, that several gaps have been filled in the developmental series of the species described in Part I. Further, I am now able, thanks to the "Thor's" material, to describe and figure a quite complete series of the postlarval stages of *Gadiculus argenteus*, the pelagic young of which were found in great quantities in the Atlantic Ocean to the west of the British Isles.

In the present paper I shall describe the developmental stages of various species omitted from Part I and also give a summary, for diagnosing purposes, of all the species. Finally, I wish to mention some divergent forms with extremely weak pigmentation of the postlarval stages of the cod, haddock and whiting from the southern North Sea, the determination of which is more difficult than is usually the case with the pelagic young of the *Gadus*-genus.

The postlarval developmental history of the various Atlantic species of *Gadus* will thus have been described and figured. It then remains to give a comparative, morphological and systematic, review over the earliest stages, a work I hope to be able to complete in a third part, which should then conclude the systematic portion of these investigations. Lastly, the final part will contain a biological description of the distribution of the pelagic young of the *Gadus*-species over the area from Iceland to the Bay of Biscay, the area over which the investigations of the "Thor" have extended.

Reference may be made to Part I for the terminology and arrangement of the material. What the present Part II contains new to Part I is the following: description and figures of divergent forms with very weak pigmentation of *G. callarias*, *aeglefinus* and *merlangus* from the southern North Sea; description and figures of the youngest postlarval stages of *G. minutus* and *luscus*; figures of older postlarval stages of *G. poutassou*; description and figures of the complete developmental history of *Gadiculus argenteus*; and an improved scheme for the determination of the postlarval stages of the *Gadus*-group.

Descriptive summary of the species of the *Gadus*-group

I. Mediolateral streak present:

1. *Gadus callarias* Linné
2. *Gadus virens* Linné
3. *Gadus pollachius* Linné
4. *Gadus saïda* Lepechin

II. **Main Group. Mediolateral streak absent. A posterolateral, transverse bar absent**

5. *Gadus aeglefinus* Linné
6. *Gadus merlangus* Linné
7. *Gadus Esmarki* Nilsson
8. *Gadus minutus* O. F. Müller
9. *Gadus luscus* Linné
10. *Gadus Poutassou* (Risso)

III. **Main Group. Mediolateral streak absent. One short posterolateral transverse bar present**

11. *Gadiculus argenteus* Guichenot

II. DESCRIPTION OF THE SPECIES

I. Main Group (Mediolateral streak present)

1. *Gadus callarias* Linné, Cod

The postlarval developmental series has been fully described from typical specimens from Iceland in Part I, and I shall therefore only mention here some divergent forms taken on a cruise made by the "Thor" at the end of April 1905 in the southern North Sea, from Esbjerg to the Dogger Bank and from there to Hull. These specimens differ from the typical in being much less pigmented. In the earliest postlarval stages before the appearance of the mediolateral streak the hindmost postanal pigment bar (cfr. Part I, Fig. 1, p. 9) for example was quite lacking in several specimens and the remaining pigment was much weaker than usual. A specimen showing this condition is figured here on Fig. 25.

As mentioned in Part I, the presence of this posterior bar in the small cod young is otherwise an important mark of recognition in contrast to the green cod (*G. virens*) and pollack (*G. pollachius*) where it is always absent, and it might be thought therefore that the absence of this bar in the cod young from the North Sea would make the certain determination of these young more difficult. This is not the case however, as it is just in being so weakly pigmented that the cod young differ from *G. virens* and *pollachius*. From *G virens* they further differ in one or more of the following characters:

(1) The preanal pigment, though weak like the rest of the pigment, is present, reaching in general quite or almost to the anus. (2) 3 V is relatively well developed, which is not the case generally in *G virens*.

Again, *G. pollachius* will probably be very easily distinguished both in the earliest and all other stages from these weakly pigmented cod young, as very strongly developed pigment is a special characteristic of this species, in which also as in the green cod the postanal pigment ends more abruptly posteriorly.

In the postlarval stages a little older, when the mediolateral streak has appeared, the weak pigmentation of the cod young from the southern North Sea offers no special difficulties to their distinction from *G. virens* and *G. pollachius*, which in these stages are very strongly pigmented. With regard to the distinguishing characters, see the descriptions in Part I. Two specimens of respectively 8½ and 12 mm. are represented here in Figs 26 and 27. They are quite easily distinguishable from *G. virens* and *pollachius*, the only other species that can come in question when it has once been decided from the presence of the mediolateral streak that they belong to the 1st Main Group[1]. The mediolateral streak may also, like

[1] The young of *Gadus virens* did not occur however along the line across the southern North Sea. Nor do they occur in the inner Danish waters, where the very weakly pigmented cod young are also to be found.

the remaining pigment, be extremely weak and sometimes consist of only a few weak chromatophores in the median line, but it never seems to be quite lacking, so that even the least pigmented specimens can thus by means of the pigment be distinguished from the species of the 2nd Main Group, of which *G. aeglefinus* and *merlangus* commonly occurred together with the cod young in our hauls along the line Esbjerg—Dogger Bank—Hull.

Weakly pigmented cod young, such as the foregoing from the southern North Sea, I have only known hitherto from the inner Danish waters. In the northern North Sea, Skager Rak, at the Færoes and Iceland I have never seen them so weakly pigmented, and it was by no means all our specimens of cod young from the southern North Sea that were so extremely weakly pigmented, nor similarly all our specimens from the inner Danish waters.

2. *Gadus virens* Linné, **Green Cod**

I have nothing new to add concerning this species to what has been given in Part I. All the specimens I have seen, from the northern North Sea, Norway, the Færoes and Iceland were strongly pigmented and very easy to distinguish from the cod.

3. *Gadus pollachius* Linné, **Pollack**

In 1905 the "Thor" took pelagic postlarval specimens of *G. pollachius* in the straits between the Hebrides and Scotland. These specimens brought nothing new of systematic importance; the fresh specimens I thus had the opportunity of examining showed however, that the pigment both on the body and the fins was quite as pronounced as that figured in Part I, Pl. I, Fig. 26—29 from specimens from the English Channel which had lain in spirit for several years.

4. *Gadus saïda* Lepechin, **Polar Cod**

Pelagic specimens of the polar cod have not been taken since the publication of Part I.

II. Main Group (Mediolateral streak absent. No posterolateral transverse bar)

1st Subgroup (end of tail not pigmentless)

5. *Gadus aeglefinus* Linné, **Haddock**

Many pelagic postlarval young of the haddock, the greater number of which were more weakly pigmented than those from the northern North Sea, west of Scotland, Færoes and Iceland, were also taken at the same stations in the southern North Sea (line: Esbjerg—Dogger Bank—Hull) where the very weakly pigmented cod young already mentioned were found. Two specimens are represented here in Figs 17 and 18 and the pigment may be even weaker than in these two. Thus the postanal ventral pigment may be quite absent. These small weakly pigmented haddock young are however easily distinguished as a rule from *G. merlangus* with which they are often found: (1) by the absence of preanal pigment, which I have never found absent even in the least pigmented whiting young, (2) by the presence of the characteristically haddock anterodorsal pigment, which seems to be the last to go in the haddock, (3) lastly, the abdominal pigment is as a rule distinctly more developed in the haddock than in the whiting. In the postlarval stages a little older the haddock young are easily distinguished from the whiting by the early development of the ventrals and the unpaired fins, by the form and relative positions of the fins and so on, as has been described and figured in Part I.

6. *Gadus merlangus* Linné, Whiting

As mentioned, a large number of small weakly pigmented whiting young were taken in the southern North Sea at the same stations as the cod and haddock young. Many of these, one ($8^1/_2$ mm. in length) is represented here in Fig. 24, lacked entirely or almost entirely the postanal dorsal pigment, so that of the whiting's normal pigment little else remained but the preanal pigment and the postanal ventral. These whiting young were, as mentioned, distinguishable from the haddock young especially by the possession of preanal pigment. They are distinguished from the young of *G. Esmarki*, which however did not occur in the southern North Sea with the whiting, by the smaller and more numerous postanal ventral chromatophores, which do not have the pronounced stellate form characteristic of the chromatophores of *G. Esmarki* and *G. minutus*, nor are they arranged in a bifurcate row as in these species (cf. Plate Fig. 19a and Part I, Pl. II, Fig. 2a and Pl. III, Fig. 1a).

7. *Gadus Esmarki* Nilsson, Norway pout

I have nothing to add to the description of the postlarval stages of this species already given in Part I and to what will be said here in describing the youngest stages of *G. minutus*. It is mentioned in Part I, p. 40 that *Gadus Esmarki* (which has been considered a comparatively rare or at least very local species) was extremely numerous at the south and west coasts of Iceland and in the Skager Rak, and in the northern part of the North Sea T. W. Fulton found (adult) specimens in thousands[1]. I can now add to this, that the pelagic young also occurred in very large numbers in the northern part of the North Sea. Thus many hundreds of postlarval specimens were taken per haul ($^1/_2$ hour) on the "Thor's" journey from Aberdeen to Bergen in the beginning of May 1905, and they also proved to be very common at the Færoes.

8. *Gadus minutus* O. F. Müller, poor cod

Only the somewhat older postlarval and the young stages were described and figured in Part I. During the cruise of the "Thor" through the English Channel in June 1905 we succeeded however in obtaining material of the youngest postlarval stages also, a description of which I may give here.

Description

Fig. 19, 19a

$6^1/_2$ mm. The posterior part of the notochord is strong but already at this length is not quite in the same line with the front part. The free portion of the end is longer than half the distance from its tip to the posterior margin of the caudal fin. Above and below the caudal fin shows very distinct interspinous rays and also the developing fin-rays, but the central portion of the fin still lacks rays. Distinct beginnings of the interspinous regions are also to be seen in A^1 and A^2 as in D^2 and D^3 (in D^1 they are but weak); they appear as folds which (in contrast for example to *G. luscus* and *Poutassou*) are very low and long. The form of the body is very slender and tapers quite unusually evenly from the snout to the tip of the tail. The dorsal and ventral outlines of the front part of the body are peculiarly straight and parallel and the mandible is almost quite vertical in relation to the longitudinal axis and the snout short and very blunt. The eyes are specially large and strongly convex. The pectorals are fan-shaped without true rays, and traces of the ventrals can not yet be seen.

The pigment resembles that in *G. Esmarki* and is on the whole weak. The preanal pigment consists of a few small stellate chromatophores. A few stellate chromatophores are present on the neck. The abdominal pigment is weak. The postanal pigment consists of large and distinct branched stellate chromatophores closely resembling in form those of *G. Esmarki*. The ventral row is composed of very

[1] T. W. Fulton: 19th Annual Report of the Fishery Board for Scotland 1901, p. 282.

closely placed chromatophores, which extend from the anus to the beginning of the interspinous region in the caudal fin. Seen from the ventral aspect (Fig. 19a) the ventral pigment row is already bifurcate anteriorly just as was described for *G. Esmarki* in Part I. In the present specimen the ventral row consisted of ca. 9 unpaired and ca. 6 paired chromatophores. The dorsal pigment is more dispersed than the ventral, especially in front, and the anterodorsal chromatophores are weaker and more separated than the posterodorsal. About 8 well-marked posterodorsal chromatophores were present.

7¼ mm. What has been said above on the form of the head and body, position of the mandible and size of the eyes still holds. The end of the notochord is fairly strongly bent upwards and rays are present in the greater part of the caudal fin. The interspinous regions in the dorsal and anal fins are more distinct than before, but no signs of rays are yet present and the embryonic fin is broad. The anus lies under the anterior edge of the incipient D^2. Fig. 20

The pigment is the same as before in the main and but little conspicuous on the whole. The ventral row is also more dispersed than in the previous stage. This has come to pass through the anterior anteroventral chromatophores moving a little more towards the left, whilst the succeeding anteroventral chromatophores have moved a little more to the right side. A preanal row is present, reaching almost to the anus.

8½ mm. The form, position of the jaw and size of the eyes are essentially as in the foregoing stages. Rays are now present everywhere in the caudal fin and the end of the notochord is strongly bent upwards and already somewhat reduced. The interspinous regions in the dorsal and anal fins are still very long and low (narrow). Rays are beginning to appear in these fins (ca. 8 in A^1, ca. 8 in A^2, ca. 10 in D^3, ca. 13 in D^2, ? in D^1). The embryonic fin has become very low. The ventrals appear as low, wart-like processes. Fig. 21

The pigment is weak on the whole. Some few occipital and preanal chromatophores are present. Of the postanal pigment there is only a few scattered posteroventral and posterodorsal chromatophores, both the anterodorsal and anteroventral pigment being absent in the specimen figured. In other cases however the ventral row was more complete (as in Fig. 22).

9½ mm. The form still tapers unusually evenly from in front backwards. The snout is very short and blunt, and the eyes are very large and strongly convex. The end of the notochord is extremely slender and much bent upwards. The length of its free portion is only ca. $^1/_4$—$^1/_5$th of the distance from its tip to the posterior margin of the caudal fin. The latter is narrow and slender. The embryonic fin is low, but the fins are not yet separate. Most of the rays in the dorsal and anal fins reach out to the margin of the embryonic fin. The following number of rays was counted: A^1 ca. 17, A^2 ca. 16, D^3 ?, D^5 ca. 13, D^1 ?. D^1 is already very distinctly separated from the others. The ventrals have increased in length but are still wart-like. The anus lies almost under the interspace between D^1 and D^2. Fig. 22

The pigment as in the previous stage is on the whole not very conspicuous. The preanal pigment consists of distinct stellate chromatophores and reaches almost to the anus. About 6 very large branched chromatophores are present on the occiput. The abdominal pigment is weak and for the most part not on the surface. In the postanal pigment there is a complete row of large branched ventral chromatophores (or more correctly 2 rows, the originally marginal row having divided into two ventrolateral, each consisting of 12—13 chromatophores). The row extends backwards from the anus almost to the beginning of the caudal fin. A single or two small chromatophores are also present at the end of the tail. The dorsal row is incomplete in front. It consists of ca. 8 posterolateral chromatophores of similar appearance to the ventral but a little smaller.

Fig. 23 **16 mm.** The body is thick in front of the anus, but yet very evenly tapering posteriorly towards the end of the tail. The height at the caudal peduncle (i. e. at the beginning of the caudal fin) is very small, so that the body seems as if it were slightly contracted at this place. The eyes are very large and prominent, quite standing out of the sockets. The snout is unusually short and blunt and the mandible has still a markedly vertical position (i. e. it forms a large angle with the longitudinal axis). The caudal fin is slender and its posterior margin slightly concave. The end of the notochord is quite reduced. The unpaired fins are quite separate and the embryonic fin has disappeared. The following number of rays were counted: D^1 ca. 11, D^2 ca. 18, D^3 ca. 19, A^1 ca. 25, A^2 ca. 21. Pigment is quite absent from the fins. All the fin rays are brittle. D^1 is relatively well-developed, and is already higher than the other dorsal fins. The ventrals are still short, between $^1/_3$ and $^1/_2$ of the diameter of the eye. The anus lies under the interspace between D^1 and D^2.

The pigment is essentially as before and on the whole not conspicuous. The preanal row is weak, but yet present. There are now considerably more occipital chromatophores. Postanally there is a ventral row of ca. 12 branched chromatophores, which reach from the anus to the beginning of the caudal fin. (On account of its position a little up on the side this row should rather be called ventro-lateral). Anterodorsal chromatophores are wanting, but on the other hand a short row of well-separated posterodorsal branched chromatophores is present.

It is unnecessary to describe further stages here, especially as the older have already been described and figured in Part I. An examination of the youngest postlarval stages mentioned here shows that the opinion expressed in Part I is fully borne out, namely, that *G. minutus* stands in no way specially near to *Gadus luscus* nor does it represent the early stages of this species. On the contrary they are extremely different in their developmental histories and any desire to place them together has therefore been quite in error. On the other hand, it has proved that *G. minutus* has its nearest and obviously close relative in *Gadus Esmarki*, a form which up to recent years has not been very well known by the ichthyologists of Middle Europe and Great Britain but is nevertheless exceedingly common in the northern North Sea, Skager Rak, at Scotland, the Færoes and Iceland. It is therefore not the two species *G. minutus* and *G. luscus* that are difficult to distinguish, the difficulty lies in separating *G. minutus* from *G. Esmarki*, and a little more may therefore be said about the matter. In pigmentation *G. Esmarki* and *minutus* resemble one another so very closely, that I cannot point out any difference of importance, though the pigment in the former is perhaps more pronounced than in the latter. They both belong to the "palest", i. e. the least pigmented of the *Gadus*-young, in which the lateral aspects remain very long without pigment, and they are both remarkable, as contrasted with the remaining species, in having very large stellate branched chromatophores, the postanal ventral pigment especially consisting of these. Both species further belong to the group in which the postanal pigment continues, gradually decreasing in strength, to or near to the end of the tail.

The difference between the postlarval stages of the two species lies in the following:

1. The eyes are considerably larger and more convex in *G. minutus* than in *G. Esmarki*.
2. The snout is shorter and blunter in *G. minutus* than in *G. Esmarki*, the mandible is more vertical (in relation to the longitudinal axis of the fish) and the dorsal and ventral outlines of the foremost part of the body are more parallel and straight.
3. The end of the notochord is bent upwards and reduced at a much smaller total length in *Gadus minutus* than in *G. Esmarki*; just as the fins are laid down and are developed at a much smaller total length in *G. minutus* (cf. the description in Part I, p. 41—42 of a *G. Esmarki* of $8^1/_2$ mm. with the description given here of a *G. minutus* of the same length, also Part I, Pl. III, Fig. 2 with the

present Fig. 21). Thus the last formed of the unpaired fins, namely D^1, is also developed earlier and earlier becomes higher than the other dorsal fins in *G. minutus* than in *G. Esmarki.*

4. The somewhat older postlarval stages of the two species are distinguished, as mentioned in Part I, both by the number of fin rays (especially in A^2) and by the form of the body, the latter in *G. minutus* being considerably thicker anteriorly (though tapering evenly posteriorly) than in *G. Esmarki.*

Verification of the determinations

This was extremely easy, especially as the early postlarval stages described here, both in pigment and other features, were quite continuous with the developmental series beginning with stages of $11^1/_2$ mm. described in Part I.

Occurrence within the region investigated by the "Thor"

Pelagic specimens were found by the "Thor" only in the English Channel (at the end of June), but young bottom stages also occurred in the southern North Sea.

The distribution of the postlarval stages of *G. minutus* and *Esmarki* is of great interest, as these two nearly related species are very unevenly distributed within the region investigated by the "Thor", in which they so to speak mutually exclude one another to a certain extent. Thus *G. minutus* is absent from Iceland, where *G. Esmarki* is exceedingly common, and on the other hand *G. minutus* is common in the English Channel and southern North Sea, where the pelagic stages of *G. Esmarki* were not found at all.

2nd subgroup (end of tail pigmentless)

9. *Gadus luscus* Linné, Pout or Bib

Of this species also the 1905 cruise of the "Thor" has brought us the youngest postlarval stages, which were wanting in the description of the developmental series in Part I.

Description

$4^1/_2$ mm. The body-form shows nothing unusual. Fig. 13

The notochord is quite straight. There are slight traces of interspinous rays below and above in the caudal fin, but indications of rays and interspinous rays are elsewhere quite wanting. The pectorals are fan-like folds of skin without traces of rays. The eyes are large.

The pigment is well-developed and very characteristic. The preanal pigment consists of a well-marked row of chromathophores reaching to the anus. The abdominal pigment is also strong. Occipital pigment is present. The postanal pigment is conspicuous and consists of a dorsal streak, which reaches from about the pectoral region barely to the middle of the postanal portion of the body and is well-marked posteriorly, as also of a ventral streak which extends right from the anus as far back as the dorsal streak or even a little further. The sides are otherwise without pigment, likewise the end of the tail, which, as the dorsal and ventral streaks end very abruptly posteriorly, stands out in sharp contrast to the remaining part of the body.

$7^1/_4$ mm. The characteristic short and high body form of this species begins already to appear, Fig. 14
though it is still far from being so prominent as it becomes later. Thus the body especially in front of the anus is relatively high. The end of the notochord is already somewhat bent upwards, and traces of rays are present over the whole caudal fin. The interspinous regions are now marked off, very distinctly in A^2, D^3 and D^2 but they are also distinct in A^1 and D^1. These interspinous regions have a very

characteristic appearance, being (as in *G. Poutassou*, cf. Part I, p. 59) unusually high and short as well as very opaque. Their form is almost triangular the front margin being high and nearly vertical. As they are particularly high and dense in D^3 and A^2, this causes the body to appear very suddenly reduced from D^3 and A^2 posteriorly towards the end of the tail. A few, short but fairly distinct traces of rays are present in the dorsal and anal fins except in D^1 where they are still undeveloped. The embryonic fin is still broad everywhere. The ventrals appear as small tiny warts in front of the pectorals. The anus lies almost under the beginning of the interspinous region in D^2.

The pigment is more developed than in the first described stage. The preanal and abdominal pigments are distinct as also the occipital. The dorsal and ventral streaks are well-marked; they reach to a little behind the beginning of D^3 and A^2. In addition to these two streaks there is now some dorso- and ventrolateral pigment composed of large stellate chromatophores. Posteriorly this pigment reaches as far back as the streaks. The mediolateral region is still free of pigment. As previously, the ventral streak reaches quite as far back as the dorsal or a little further (in contrast to *Gadus Poutassou*), and as the pigment ends abruptly posteriorly the end of the tail is still in sharp contrast to the remaining portion of the body. The contrast is increased by the absence of the yellowish tinge on the end of the tail which is present on the front part of the body and which comes from small yellow chromatophores to be detected in the living specimen between the black both postanally and on the occiput.

Fig. 15 **11 mm**. The body is now conspicuously short and high both in front of and behind the anus, and narrows suddenly behind the last dorsal and anal fins. The eyes are large. The end of the notochord is greatly reduced (very slender) and much bent upwards. The caudal fin is narrow and almost straight posteriorly. The following number of rays could be counted: D^1 ca. 9, D^2 ca. 17, D^3 ca. 19, A^1 ca. 24, A^2 ca. 20. The embryonic fin is still fairly broad between the hindmost dorsal and anal fins. Whilst the interspinous regions in D^2 and D^3 are distinctly separate, those in A^1 and A^2 join on to one another almost without a break. The ventrals have grown beyond the wartlike stage and are in front of the pectorals. The anus is under the end of D^1.

The pigment is essentially as in the previous stage. The dorsal and ventral streaks, the latter reaching a little further back than the former, do not yet reach to the middle of D^3 and A^2. Pigment is absent from the fins.

Fig. 16 **13 mm**. The form of the body is very short and high both in front and behind the anus and narrows sharply towards the end of the tail. The notochord is almost quite reduced (extremely slender). The eyes are of considerable size. The caudal fin is slender and long with an almost straight posterior margin. The embryonic fin can still be noticed but is only broad between A^1 and A^2 and D^2 and D^3. The following number of rays were counted: D^1 ca. 11, D^2 ca. 19, D^3 ca. 20, A^1 ca. 31, A^2 ca. 21 (or rather $A^1 + A^2 =$ ca. 52 as it is difficult to determine with certainty where A^1 ends and A^2 begins). The fins are still for the most part without pigment; yet a few linear black chromatophores can be noticed in the posterior part of A^1 between the fin rays at the place where a black patch of pigment arises later (cf. Part I, Pl. III, Fig. 20—24). The ventrals are between $^1/_3$ and $^1/_2$ of the diameter of the eye. D^1 is already higher than the other dorsal fins. The anus lies under the second half of D^1. The pigment is essentially as before. The preanal row is still distinct and reaches to the anus. Both the dorsal and ventral streaks are very well-marked but do not yet reach to the middle of D^3 and A^2. The ventral streak extends right from the anus and reaches a little bit further back than the dorsal. A great deal of pigment is now present on the lateral aspects as far back as the dorsal and ventral rows reach, and this pigment consists of distinct stellate chromatophores. Posteriorly, the pigment still ends abruptly towards the colourless end of the tail.

With the developmental stages described here and in Part I, the series of postlarval stages of

Gadus luscus is complete. The discovery of the earliest postlarval stages in 1905 has been of essential importance for understanding the development of the pigment and other strucher al features. The species which *G. luscus* in its earliest stages resembles most and the only one with which it could be confused is *G. Poutassou*, both species being remarkable for the well-marked dorsal and ventral pigment streaks ending very abruptly posteriorly. It is specially in the very early stages, when *G. luscus* has not yet assumed its later so characteristic short and high form, that it closely resembles *G. Poutassou*, as also in the characteristic high and short (triangular) form of the interspinous regions. Nevertheless they are always easily distinguished by means of the following features.

(1) The eyes are larger in *G. luscus* than in *G. Poutassou*.

(2) The preanal pigment is well-marked in *G. luscus* where it forms a row reaching to the anus, whereas it is weak in *G. Poutassou*.

(3) The postanal ventral streak in *G. luscus* extends right from the anus and quite as far as or a little more posteriorly than the dorsal. In *G. Poutassou* it first begins a little way from the anus (so that anteroventral pigment is absent) and does not reach so far back as the dorsal streak.

The features mentioned under (2) and (3) stand in connection with the fact, that the pigment on the ventral aspect is on the whole more developed in *G. luscus* than in *G. Poutassou*, and the two species are thus similarly related to another as respectively *Gadus callarias* to *G. saïda* and *G. pollachius* to *G. virens*.

Verification of the determinations

With the somewhat older postlarval stages as described in Part I to hand, it was evident that the young stages found by the "Thor" belonged to this species, with its characteristic postanal pigment and peculiar short and high body-form.

Occurrence within the region investigated by the "Thor"

The postlarval young of *Gadus luscus* were only taken by the "Thor" (in June 1905) in the English Channel (and a single specimen off the coast of Holland) the only regions from which these stages are as yet known.

10. *Gadus Poutassou* (Risso), Poutassou

On the 1905 cruise a very large material (some hundreds of specimens) of all postlarval stages of *G. Poutassou* was taken in the Atlantic Ocean. Part I contains a complete description of the developmental series of this species based on this and earlier years' material. But only the younger stages are figured in Part I and I use this occasion therefore to give figures, partly of the older postlarval stages not included in Part I, partly of some younger stages (Figs 28, 29, length respectively 8 and 14 mm.) as the 1905 cruise brought in better and larger material of these than I had at my disposal when the figures to Part I were made. The following stages are therefore figured on the present Plate.

8 mm. This stage shows the difference in pigment and form between *G. Poutassou* and *G. luscus* (cf. Fig. 14). Fig. 28

14 mm. The figure clearly shows the form of the interspinous regions and the large interspace between D^2 and D^3 which is so characteristic of this species. Fig. 29

21 mm. The specimen figured here is described in Part I, p. 60 (in the Danish edition, p. 72). Fig. 30

25½ mm. This specimen is also described in Part I, p. 60 (Danish edition, p. 72). Fig. 31

32 mm. This is also described in Part I, p. 60—61 (Danish edition, p. 73). Fig. 32

The investigations of the "Thor" in 1903—1905 have shown that the postlarval young of *Gadus Poutassou* are common in the Atlantic Ocean in the region from south of Iceland to south-west of the Færoes and British Isles to off Brittany, that is, as far south as the investigations in those years extended. To the places mentioned in Part I, p. 61—62 where the specimens were found in 1903 and 1904 I may add here the most important places where they were taken in 1905.

Stat. No.	Situation	Depth in meters	Meters wire out	No. of specimens	Length of specimens mm.
58	63° 07′ N, 16° 12′ W	1475	30	1	ca. 11
»	»	»	65	5	» 12—14
60	61° 50′ N, 11° 38′ W	1110	25	6	» 6—9
»	»	»	65	45	» 5—15
»	»	»	1000	2	» 10, ca. 20
61	61° 11′ N, 11° 00′ W	963	25	34	» 5—25
»	»	»	65	12	» 10—30
»	»	»	900	9	» 5—11
62	60° 43′ N, 10° 42′ W	210	25	1	» 10
63	59° 49′ N, 8° 58′ W	1150	25	69	» 5—15
»	»	»	65	20	» 5—30
»	»	»	1200	1	» 12
64	59° 17′ N, 7° 29′ W	895	25	ca. 150	» 6—30
		»	65	37	» 9—32
»	»	»	1000	6	» 8—25
65	58° 45′ N, 6° 26′ W	100	25	1	» 5
66	58° 07′ N, 6° 10′ W	60	65	2	» 12, ca. 15
70	57° 45′ N, 9° 57′ W	1150	25	1	» 35
»	»	»	65	1	» 18
72	57° 52′ N, 9° 53′ W	1020—1490	25	3	» 20—42
»	»	»	65	179	» 20—45
»	»	»	100	14	» 28—58
»	»	»	200	5	» 4—25
»	»	»	300	8	» 16—46
73	56° 56′ N, 9° 22′ W	1180—1390	100	6	» 30—50
74	56° 00′ N, 9° 32′ W	1040—1520	200	1	» 30
»	»	»	300	1	» 35
76	55° 56′ N, 9° 40′ W	1390—1405	300	1	» 45
81	51° 32′ N, 12° 03′ W	960—1420	300	1	» 53
89	47° 33′ N, 7° 40′ W	500	300	2	» 150
116	58° 46′ N, 0° 7′ W	140	350	1	» 45

The three years' investigations show: (1) that the young of *G. Poutassou* are born over great depths and not in shallow waters near the coasts like the other *Gadus*-species, (2) that *G. Poutassou* is a true Atlantic form, which has its home and reproduces in the true Atlantic waters west of the Iceland—Færoes—Scotland Ridge and west of the British Isles. It was only in those regions and not more northerly than ca. 62 N.L. that the youngest and early stages were found, though the older developmental stages are common both in the Skager Rak and in the northern North Sea, to some extent also in the Norwegian Sea. In *G. Poutassou* we thus have an interesting example of a species which at certain stages of its life-history can be found in quantities in waters where it does not reproduce, and it gives us along with the recently discovered young of the fresh-water eel (*Anguilla vulgaris*) the first example of a species whose breeding-centre is in the true Atlantic Ocean to the west of Great Britain.

III. Main Group. Mediolateral streak absent. One very short posterolateral transverse bar present

11. *Gadiculus argenteus* Guichenot, **Silver cod**

Principal literature and figures:

Larval stages: undescribed. Postlarval stages: undescribed. Young stages: Holt & Calderwood (1895, p. 435); Johs. Schmidt (Part I, p. 64—66, Pl. III, Fig. 25).

Description

4 mm. The body is very short and plump, the preanal part being so extremely heavy in appearance that the species at this stage reminds one of the tiny *Onos*-young. The notochord is quite straight. The embryonic fin is broad. Distinct signs of the interspinous region are not yet to be seen in the caudal fin, where there are only embryonic rays, nor are there the least traces of the interspinous regions at the parts where the dorsal and anal fins develop later. The pectorals are fan-shaped without rays. Fig. 1

The preanal pigment is distinct but is far from reaching to the anus and in other specimens it is weak. The abdominal pigment is fairly well-developed but for the most part not superficial. A few chromatophores are present on the supraorbital and postoccipital regions as also on the snout and under jaw. The postanal pigment is extremely characteristic and consists only of a single very short and deep-black cross bar, which is situated a little behind the middle of the postanal portion of the body. The bar consists of a dorsal and a ventral portion, the part between being without pigment. The dorsal part is as a rule more developed than the ventral. Otherwise postanal pigment is quite lacking.

5 mm. The body in front of the anus is still very plump. The notochord is quite straight. Very slight traces of the interspinous regions can be seen below and above in the caudal fin. The embryonic fin has begun to be a little opaque at the part where the rays appear later but these are not yet laid down. The pigment is essentially as in the previous stage, but there is now a lateral portion between the dorsal and ventral parts of the postanal bar. Fig. 2

5½ mm. The body is still very plump in front and the notochord is quite straight. The interspinous regions in the caudal fin are a little more distinct than before; also the opaque part in the caudal fin is more apparent but rays are not yet formed. In D^3 and A^2 there are very low signs of the interspinous regions. Fig. 3

The pigment is essentially as before. The postanal bar lacks here the ventral part but this is present in other specimens.

6 mm. The body is still very plump, and the notochord is also almost quite straight. The interspinous regions in the caudal fin are distinct and the formation of rays has also begun. Further the interspinous regions are distinct in D^3 and A^2, also in D^2 and A^1 and can even be detected in D^1. There are as yet no signs of rays however in the dorsal and anal fins. The interspinous regions are characteristically short and high. The anus lies under the beginning of the interspinous region in D^2. Fig. 4

The preanal pigment is distinct but does not reach to the anus and may be weak in other specimens. With exception of the short bar there is no postanal pigment.

7¼ mm. The body is still very plump and short. Development is otherwise considerably more advanced than in the last stage. The end of the notochord is already considerably reduced and a little bent upwards. Rays are present in the greater part of the caudal fin. In A^2 there are ca. 8, in A^1 ca. 9 traces of rays yet not very distinct. In D^3 there are ca. 9, in D^2 ca. 5 traces of rays but these are not clearly marked off in D^1. The interspinous regions (especially in D^2) are very high especially in Fig. 5

front. The ventrals can just be detected as very small and wart-like processes. The embryonic fin is still very broad. The anus lies under the beginning of D^2.

The pigment is essentially as before, The abdominal pigment is very well-marked, as also the pigment dorsally behind the occipital region.

Fig. 6 **9 mm.** The body is still very short and plump. The end of the notochord is greatly reduced and bent upwards, and rays are now everywhere present in the caudal fin. The embryonic fin is low opposite the interspaces between the developing fins. The following number of rays could be counted: A^1 ca. 14 (the last 3 small), A^2 ca. 13, D^1 ca. 6, D^2 ca. 9, D^3 ca. 12. The anus lies a little in front of D^2. The ventrals are wart-like. The pigment is as before.

Fig. 7 **10 mm.** The body is still very plump. The end of the notochord is now very slender. The fins have about the same number of rays as in the previous stage. The ventrals are now longer. The anus lies a little in front of D^2.

The pigment is very well-marked in the specimen figured. The postanal bar is specially conspicuous and consists of large stellate chromatophores; otherwise there is only a single anteroventrolateral chromatophore behind the anus. The supraorbital and postoccipital pigments are well-marked; from the latter a streak of pigment extends backwards dorsally almost to the end of D^1.

Fig. 8 **13 mm.** The body is plump and reminds one not a little of the haddock. The end of the notochord is now quite reduced. The following number of rays could be counted: A^1 ca. 16, A^2 ca. 17, D^1 ca. 7—8, D^2 ca. 12, D^3 ca. 12—13. The rays are thick but very brittle. The fins are now separated. The anus lies under the end of D^1.

The pigment is as before, and is quite wanting postanally except for the still very prominent posterolateral bar.

Concerning the pigment in the living condition it may be said that the eyes, the size of which is considerable, are a dark-blue, almost black with weak silvery lustre. A little yellow pigment is present on the occiput and the lateral aspects of the abdomen have a reddish tinge. Postanally there is no coloured pigment.

Fig. 9 **15¾ mm.** The body form is plump but yet tapering more evenly posteriorly than in previous stages. The caudal fin is slender and almost straight posteriorly. The following number of rays could be counted in the dorsal and anal fins: A^1 ca. 18, A^2 ca. 18, D^1 ca. 10, D^2 ca. 12, D^3 ca. 18. The ventrals are now long equal at least to the diameter of the eye.

The pigment is essentially as before. Pigment has begun to spread out forwards from the ventral portion of the posterolateral bar along the base of A^2, reaching forward almost to its beginning. A single dorsal chromatophore is present opposite D^2, but otherwise there is no further postanal pigment.

Fig. 10 **21 mm.** The body is heavy in front but tapers evenly posteriorly. The caudal fin is slender, with almost parallel upper and lower margins and almost square posteriorly. The anus lies under the posterior third of D^1. The eyes are very large with a diameter of ca. 1¾ mm. The ventrals are long and pointed and reach more than halfway to the anus measured from their base. They are very often broken. The following number of fin rays could be counted in the unpaired fins: A^1 ca. 14, A^2 ca. 16, D^1 ?, D^2 ca. 10, D^3 ca. 15.

The pigment now shows characteristic differences from the previous stage. The anterodorsal pigment extends backwards and thus joins on to the dorsal portion of the postanal bar which has grown forwards. With exception of this bar and a little in front of it the ventral aspect is still free of pigment. The chromatophores in the bar are large and stellate. Viewed from above the dorsal pigment is seen

to be collecting into groups: No. 1 at the beginning of D^1, No. 2 at the beginning of D^2, No. 3 which is weak almost midway between D^2 and D^3, No. 4 at the beginning of D^3, No. 5 on the place of the original bar, that is, opposite the end of D^3. The end of the tail is still quite unpigmented as also the lateral aspects in front of the bar.

29 mm. The body is very heavy anteriorly, but tapers evenly (wedge-shaped) towards the tail. The caudal fin is slender and fairly narrow; posteriorly it is almost square across or perhaps slightly concave. The following number of rays could be counted: A^1 ca. 16, A^2 ca. 15, D^1 ca. 10, D^2 ca. 12, D^3 ?. The ventrals are now much longer than the diameter of the eye (which is ca. $2^1/_2$ mm.) and reach quite to the anus. This lies under the posterior third of D^1. The pectorals are considerably narrower than before and are fixed very low down. Pigment is lacking in the fins. Fig. 11, 11a

The pigment is more distinct and more developed than before. This is also true of the dorsal grouping which is much more distinct (cf. Fig. 11a). The pigment group No. 3 is still relatively weak. The end of the tail also is now pigmented. There is further some anteroventral pigment and the original bar is therefore no longer so exceedingly prominent as before though still very conspicuous, as the chromatophores forming it are very large and the lateral aspects otherwise are for the most part lacking in pigment.

36 mm. The body is still very heavy (thick) in front but tapers evenly posteriorly. The characteristic pits on the head which characterise this species can be easily recognised at this stage. The eyes are now very large, quite $3^1/_2$ mm. in diameter and larger than in any *Gadus*-species of the same length (*Gadiculus* is a deepwater fish). The following number of rays could be counted: A^1 16, A^2 15, D^1 ca. 9, D^2 ca. 12, D^3 ca. 16, the caudal fin 42—43. The ventrals are long and pointed and reach beyond the anus, which lies under the last third of D^1, but like the other fins of this species they are fragile and break easily (this affects the specimen figured in Part I, Pl. III, Fig. 25). Pigment is absent from the fins. The caudal fin is narrow and almost straight posteriorly. A^1 and A^2 have about the same length at their base. Fig. 12

The pigment is the same as previously but more pronounced. The original bar is still clear and the greater part of the lateral aspect lacks pigment as before.

This stage is one of the largest we have taken. It was still pelagic. At a length of about 4 cm. however *Gadiculus* gives up its pelagic mode of life and becomes a bottom-fish in deep water (cf. the bottom-stages described in Part I).

Material

The collection of *Gadiculus argenteus* is very rich and contains over a thousand postlarval specimens in all stages of development taken in the Atlantic Ocean on the stretch from the Færoes to off the south-west of Ireland.

Verification of the determinations

This was extremely easy as *Gadiculus argenteus* was the only species belonging to the *Gadus*-group whose postlarval stages had not previously been described in Part I of this work. Further the number of fin-rays was decisive (cf. Part I, p. 53) and finally the very characteristic posterolateral pigment bar which was already shown in Part I to be present in the bottom-stage of 42 mm. long showed that this was the only species in question. From the quite small postlarval stages taken in 1905 we see further that only the most posterior of the 5 pigment-bars mentioned in Part I p. 65 is primary (i. e. present in the earliest stages). The others are only developed at a length of about 2 cm. As shown in Part I the bar-arrangement disappears later but may still be detected in specimens of ca. 7 cm. in length.

Occurrence within the region investigated by the "Thor"

The distribution of the pelagic young of *Gadiculus argenteus* agrees for the most part with that of the pelagic young of *G. Portassou*. The most important places where it was taken are shown in the following list.

Stations[1] where the pelagic young of *Gadiculus* were taken 1905:

Stat. No.	Meters wire out	Numbers of specimens	Length in mm.	Stat. No.	Meters wire out	Numbers of specimens	Length in mm.
60	65	15	5—8	74	200	30	8—15
»	1000	2	5	»	300	79	5—20
61	25	16	6—14	75	300	13	6—20
»	65	5	4—12	76	200	3	6, 18, 25
»	900	12	4—9	»	300	76	5—23
63	25	1	11	81	200	1	11
»	65	29	5—11	»	300	23	8—30
»	1200	4	5—8	82	200	3	16—20
62	25	14	4—10	»	300	6	6—10—22
»	65	44	5—12	»	800	1	15
»	1000	24	5—13	86	65	1	25
65	65	3	4—9	121	500	3	30
70	65	20	5—16	122	65	1	8
71	300	33	5—15	»	125	5	4—7
»	1500	11	3—5	123	65	3	5
72	200	386	6—20	»	200	1	12
»	300	308	5—20	129	500	2	12
»	600	43	5—20	164	65	2	8, 18
»	1500	41	5—15	165	100	2	12, 30
73	100	1	8	167	250	1	ca. 25
»	250	11	5—25	»	300	1	36
»	300	147	8—22				

The pelagic young of this species have been found distributed in the Atlantic Ocean from ca. 63° N.L. and southwards west of the British Isles as far as off Brittany (the investigations of the "Thor" did not extend further south than this), but almost exclusively over great depths only (about the 1000 m. curve or even deeper). *Gadiculus* must therefore also be called a true Atlantic species, which has its true centre outside Northern Europe in the Atlantic Ocean west of the Iceland—Færoes Ridge and the British Isles, even though its older stages may also occur in the Skager Rak and northern North Sea. So far it resembles *G. Poutassou* in its biology, but it differs from this species, which is entirely or partly a pelagic species, by being a true bottom-form normally belonging to deep water and frequenting greater depths than the *Gadus*-species, as is shown also by its very large eyes.

[1] With regard to the situation and depth at the stations. see list on the distribution of the postlarval young of *Gadus Poutassou*, p. 12. Further have to be mentioned: **St. 71**, 57°47′N., 11°33′W.; depth, 1985 meters. **St. 75**, 56°00′N., 9°57′W.; depth, 2050 m. **St. 82**, 51°00′N., 11°43′W.; depth, 840—1400 m. **St. 86**, 49°14′N., 8°45′W.; depth 95 m. **St. 121**, 61°31′N., 0°39′W.; depth, 196 m. **St. 122**, 59°48′N., 1°23′W.; depth, 85 m. **St. 123**, 60°15′N., 2°38′W.; depth, 157 m. **St. 129**, 62°40′N., 8°43′W.; depth, 512 m. **St. 164**, 61°20′N., 11°00′W.; depth, 1300 m. **St. 165**, 60°00′N., 10°35′W.; depth, 1050 m. **St. 167**, 57°46′N., 9°55′W.; depth, 625—1425 m.

III. SCHEME FOR THE DETERMINATION OF THE POSTLARVAL STAGES OF THE SPECIES OF *GADUS*

I may conclude this part by giving an improved scheme for the determination of the postlarval stages of all the species of the *Gadus*-group.

A. The youngest postlarval developmental stages up to about 8—10 mm. in length

I. Main group. 3 (or 2) postanal transverse bars of pigment (3, 2, 1) are present, arranged according to the type represented on page 29, Part I.

(a) Bar 1 is present. (See p. 4.)

Only the ventral portion of bar 1 present. Dorsal pigment less pronounced than the ventral ..... *Gadus callarias* (Fig. 1, Part I)

Only the dorsal portion or both dorsal and ventral portions of bar 1 present. Dorsal pigment more pronounced than the ventral ..... *Gadus saïda* (Fig. 4, Part I)

(b) Bar 1 absent. (See p. 4.)

The bar-arrangement quickly disappears owing to the early fusion of the dorsal portions as also of the ventral portions of the pigment. Both dorsal and ventral streaks extend far back towards the tail, the unpigmented end of which is in consequence proportionately short. Preanal pigment distinct generally reaching to the anus *Gadus pollachius* (Fig. 3, Part I)

The bars remain separate for a long time. Both dorsal and ventral portions of bar 2 are somewhat short, so that the unpigmented portion of the end of the tail is proportionately long. Preanal pigment weak generally not reaching to the anus ..... *Gadus virens* (Fig. 2, Part I)

II. Main group. Postanal transverse bars arranged according to the type represented on page 29, Part I are absent.

(a) The postanal pigment ends abruptly a considerable distance in front of the end of the tail.

Dorsal pigment extends further back than the ventral. Preanal pigment weak generally not reaching to the anus ..... *Gadus Poutassou* (Fig. 16, Part I)

Dorsal pigment does not extend further back than the ventral. Preanal pigment distinct generally reaching to the anus ..... *Gadus luscus*

(b) The postanal pigment does not end abruptly a considerable distance in front of the end of the tail.

(α) The most pronounced and constant portions of the pigment are the anterodorsal and abdominal. Posterodorsal and preanal pigment very weak or wanting. The body in front of the anus is very plump ..... *Gadus aeglefinus* (Fig. 10, Part I)

(β) The most conspicuous portions of the pigment are the postanal ventral and dorsal and the anterodorsal is not specially prominent. Preanal pigment distinct.

The dorsal row of pigment generally extends unbroken from the pectoral region to near the end of the tail. The ventral row consists of numerous small, closely placed chromatophores ..... *Gadus merlangus* (Fig. 11, Part I)

III. Main group. Only one very short posterolateral transverse bar is present. The body is very short and plump ..... *Gadiculus argenteus*

The dorsal row of pigment is broken on the region over the anus and consists of few but larger and less closely placed chromatophores than in *Gadus merlangus*.

Eyes very large ..... *Gadus minutus*

Eyes not very large ..... *Gadus Esmarki* (Fig. 12, Part I)

B. Stages from about 8—10 up to about 15—20 mm. in length

I. Main group. Mediolateral streak present.

(a) The postanal pigment does not end abruptly some distance in front of the end of the tail, which consequently is not in sharp contrast to the pigmented portion of the body. Pigment is present as a rule on the end of the tail.

Preanal pigment is well-developed and extends posteriorly almost to the anus. The end of the notochord is already slightly bent upwards at a length of 11 mm. The body not extremely elongated ..... *Gadus callarias*

Preanal pigment is weak and far from reaching to the anus posteriorly. The end of the notochord is still straight at a length of 16 mm. The body extremely elongated ..... *Gadus saïda*

(b) The postanal pigment ends abruptly some distance in front of the end of the tail, which is pale and unpigmented, thus standing out in marked contrast to the pigmented portion of the body.

The preanal pigment is well-developed and reaches posteriorly almost to the anus. The postanal pigment is evenly distributed over the sides and is very conspicuous. The caudal fin is very broad and square posteriorly. The anus lies a considerable distance in front of D^2..... *Gadus pollachius*

The preanal pigment is weak and does not reach posteriorly to the anus. The sides are densely pigmented with exception of a lighter, roundish part centrally, where the mediolateral streak is often broken. The anus lies a little in front of D^2 .. *Gadus virens*

II. Main group. Mediolateral streak wanting. A posterolateral transverse bar not present.

(a) The postanal pigment ends abruptly a considerable distance in front of the end of the tail. Apart from this the greater part of the sides is covered by pigment.

The body unusually high and narrowing abruptly towards the end of the tail. The dorsal pigment does not reach further back than the ventral..... *Gadus luscus*

The body not unusually high and not narrowing abruptly towards the end of the tail. The dorsal pigment reaches further back than the ventral ..... *Gadus Poutassou*

(b) The postanal pigment does not end abruptly some distance in front of the end of the tail.

(α) The body unusually short and plump. Pectorals and ventrals generally strongly pigmented. Posterodorsal and preanal pigment most often very weak or wanting. Anus far back, under D^2..... *Gadus aeglefinus*

(β) The body not unusually short and plump. Preanal and posterodorsal pigment generally distinct. Pectorals and ventrals not pigmented.

(x) Greater part of the sides overstrewn with pigment. Anus far forward, under D^1. No specially large chromatophores present. A^1 much longer than A^2... *Gadus merlangus*

III. Main group. Mediolateral streak wanting. A distinct posterolateral transverse bar present..... ..... *Gadiculus argenteus*

(y) Greater part of the sides unpigmented, the postanal pigment being almost exclusively restricted to the ventral and dorsal rows, which consist of large, stellate chromatophores. A^1 but slightly longer than A^2.

The body is much thicker in front than behind the anus. Eyes very large. Development of fins rapid ..... *Gadus minutus*

The body is not much thicker in front than behind the anus. Eyes not unusually large. Development of fins not very rapid ..... *Gadus Esmarki*

C. Stages from about 15—20 mm. up to ca. 30 mm.

I. Main group. Mediolateral streak present.

(a) Anus under D^2.

The body unusually elongated. A^1 reaches further back than D^2. Caudal fin forked. Development of the rays very slow. Eyes very large ..... *Gadus saïda*

The body not unusually elongated. A^1 does not reach further back than D^2. Caudal fin square posteriorly ..... *Gadus callarias*

(b) Anus under D^1.

The anus under the anterior $^1/_3$ of D^1. Caudal fin very broad posteriorly and square. Deep black pigment spots fill up a great part of the unpaired fins ..... *Gadus pollachius*

The anus under the posterior $^1/_3$ of D^1. Caudal fin concave posteriorly. The fins, especially the caudal, somewhat less pigmented than in *G. pollachius* ..... *Gadus virens*

II. Main group. Mediolateral streak wanting. A posterolateral transverse bar not present.

(a) Anus under D^2 ..... *Gadus aeglefinus*

(b) Anus under D^1.

(α) Greater part of the sides densely pigmented. Anus under the first $^1/_3$ of D^1.

(x) A^1 and A^2 connected. Body unusually high ..... *Gadus luscus*

(y) A^1 and A^2 separated. Body not unusually high.

D^2 unusually short and separated from D^3 by a large interspace. Anteroventral pigment absent ..... *Gadus Poutassou*

D^2 not unusually short nor separated from D^3 by a large interspace. Anteroventral pigment present ..... *Gadus merlangus*

(β) Greater part of the sides unpigmented. Anus under the posterior $^1/_3$ of D^1.

Snout rounded; lower jaw does not extend much further forward than the upper. Diameter of the eye almost equal to the length of the snout. Body thick in front of the anus (club-shaped anteriorly). D^1 close to D^2 ..... *Gadus minutus*

Snout flat; lower jaw extends somewhat further forward than the upper. Diameter of the eyes much larger than the length of the snout. Body narrow both in front of and behind the anus. D^1 separated by a short interspace from D^2 ..... *Gadus Esmarki*

III. Main group. Mediolateral streak wanting. A posterolateral transverse bar present ..... *Gadiculus argenteus*

DESCRIPTION OF FIGURES

Fig. 1. *Gadiculus argenteus,* **length 4 mm.**, "Thor", Stat. 61, 28th May 1905, 61° 11′ N., 11° 00′ W. Depth: 963 meters. Young-fish trawl, 900 meters wire out.
Fig. 2. *Gadiculus argenteus,* **length 5 mm.**, same haul as 1.
Fig. 3. *Gadiculus argenteus,* **length 5½ mm.**, same haul as 1.
Fig. 4. *Gadiculus argenteus,* **length 6 mm.**, "Thor", Stat. 72, 8th June 1905, 57° 52′ N., 9° 53′ W. Depth: 1020 meters. Young-fish trawl, 600 meters wire out.
Fig. 5. *Gadiculus argenteus,* **length 7¼ mm.**, same haul as 4.
Fig. 6. *Gadiculus argenteus,* **length 9 mm.**, same haul as 4.
Fig. 7. *Gadiculus argenteus,* **length 10 mm.**, same haul as 4.
Fig. 8. *Gadiculus argenteus,* **length 13 mm.**, same station as 4 (Stat. 72), 8th June 1905. Young-fish trawl, 200 meters wire out.
Fig. 9. *Gadiculus argenteus,* **length 15¾ mm.**, same haul as 4.
Fig. 10. *Gadiculus argenteus,* **length 21 mm.**, same station as 4 (Stat. 72), 8th June 1905. Young-fish trawl, 300 meters wire out.
Fig. 11. *Gadiculus argenteus,* **length 29 mm.**, "Thor", Stat. 81, 13th June 1905, 51° 32′ N., 12° 03′ W. Depth: 1090—1330 meters. Young-fish trawl, 200 meters wire out.
Fig. 11a. The same specimen as 11, seen from the dorsal aspect.
Fig. 12. *Gadiculus argenteus,* **length 36 mm.**, "Thor", Stat. 167, 31th August 1905, 57° 46′ N., 9° 55′ W. Depth: 1000—1310 meters. Young-fish trawl, 300 meters wire out.
Fig. 13. *Gadus luscus,* **length 4 mm.**, "Thor", Stat. 99, 30th June 1905, 50° 43′ N., 0° 43′ E. Depth: 41 meters (English Channel). Young-fish trawl, 65 meters wire out.
Fig. 14. *Gadus luscus,* **length 7¼ mm.**, "Thor", same station as 13 (Stat. 99), 30th June 1905. Young-fish trawl, 20 meters wire out.
Fig. 15. *Gadus luscus,* **length 11 mm.**, "Thor", Stat. 97, 29th June 1905, 50° 17′ N., 3° 14′ W. Depth: 60 meters (English Channel). Young-fish trawl, 75 meters wire out.
Fig. 16. *Gadus luscus,* **length 13 mm.**, Whitsand Bay near Plymuth, English Channel, 12th May 1902. Sent from Dr. E. J. Allen, Plymouth.
Fig. 17. *Gadus aeglefinus,* **length 5½ mm.**, "Thor", Stat. 3, 27th April 1905, 55° 12′ N., 5° 53′ E. Depth: 43 meters (North Sea, southern part). Young-fish trawl, 40 meters wire out.
Fig. 18. *Gadus aeglefinus,* **length 8½ mm.**, same haul as 17.
Fig. 19. *Gadus minutus,* **length 6½ mm.**, "Thor", Stat. 99, same haul as 14.
Fig. 19a. The same specimen seen from the ventral aspect.
Fig. 20. *Gadus minutus,* **length 7¼ mm.**, same haul as 14.
Fig. 21. *Gadus minutus,* **length 8½ mm.**, same haul as 14.
Fig. 22. *Gadus minutus,* **length 9½ mm.**, same haul as 14.
Fig. 23. *Gadus minutus,* **length 16 mm.**, "Thor", Stat. 97, same haul as 15.
Fig. 24. *Gadus merlangus,* **length 8½ mm.**, same haul as 17.
Fig. 25. *Gadus callarias,* **length 5½ mm.**, "Thor", Stat. 2, 27th April 1905, 55° 12′ N., 6° 36′ E. Depth: 41 meters (North Sea, Southern part). Young-fish trawl, 40 meters wire out.
Fig. 26. *Gadus callarias,* **length 8½ mm.**, same haul as 25.
Fig. 27. *Gadus callarias,* **length 12 mm.**, same haul as 25.
Fig. 28. *Gadus Poutassou,* **length 8 mm.**, "Thor", Stat. 63, 30th May 1905, 59° 49′ N, 8° 58′ W. Depth: 1150 meters. Young-fish trawl, 25 meters wire out.
Fig. 29. *Gadus Poutassou,* **length 14 mm.**, same haul as 28.
Fig. 30. *Gadus Poutassou,* **length 21 mm.**, same Station as 28 (Stat. 63). Young-fish trawl, 65 meters wire out.
Fig. 31. *Gadus Poutassou,* **length 25½ mm.**, same haul as 30.
Fig. 32 *Gadus Poutassou,* **length 32 mm.**, "Thor", Stat. 64, 30th May 1905, 59° 17′ N., 7° 29′ W. Depth: 895 meters. Young-fish trawl, 65 meters wire out.

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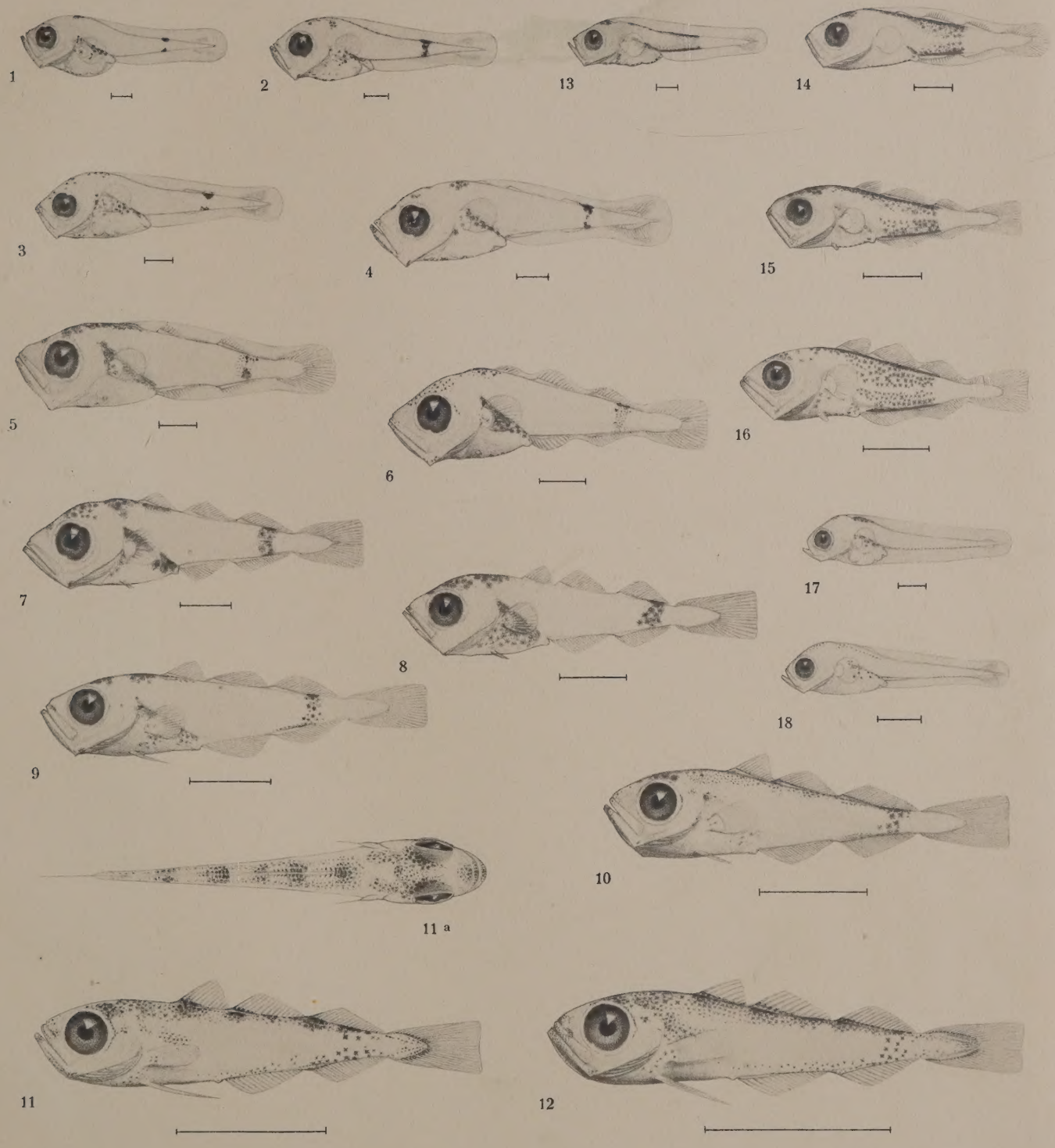

Fig. 1—12 *Gadiculus argenteus* Guichenot; Fig. 13—16 *Gadus luscus* Linné; Fig. 17—18 *Gadus aegle*
Fig. 24 *Gadus merlangus* Linné; Fig. 25—27 *Gadus callarias* Linné; Fig. 28

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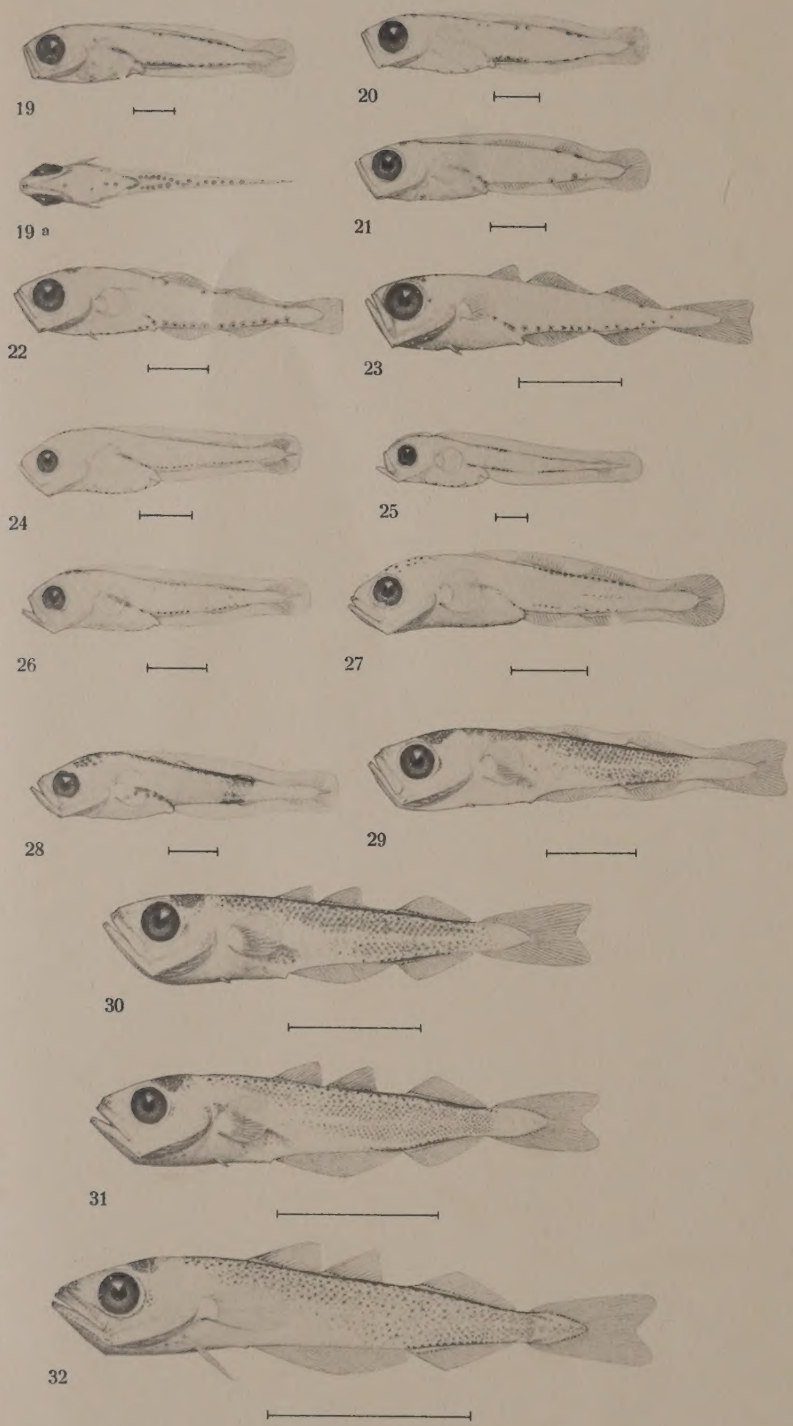

inus Linné; Fig. 19—23 *Gadus minutus* O. F. Müller;
-32 *Gadus Poutassou* (Risso).

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